

REMARKS

In the Office Action mailed September 21, 1999, the Examiner objected to claims 1 and 2, and rejected claims 1, 3-7, and 9-13 under 35 U.S.C. 103 as being unpatentable over Kakuta (U.S. Patent No. 5,636,356) in view of Miskowiec (U.S. Patent No. 5,915,095). The foregoing objections and rejections are traversed.

New claims 14-16 are added. Care has been exercised to avoid the introduction of new matter. New claim 14 corresponds to claim 1, new claim 15 corresponds to claim 7, and new claim 16 corresponds to claim 15.

Claim 1 is amended, taking the Examiner's comments into consideration. The Examiner's objections to claim 2 are obviated in that claim 2 was canceled in the Amendment filed July 8, 1999. Withdrawal of the objections to claim 1 is respectfully requested.

The present invention counts the number of request made for each drive in the disk array, compares the counted value of requests for each drive having a same logical volume, and selects the drive having a minimum counted value. Accordingly, by selecting the drive with the minimum counted value from drives storing the same logical volume, the present invention continuously balances requests among the drives. Therefore, high speed accesses to the drives can be performed by the present invention. Moreover, even though the number of requests to the particular logical volume is large, one drive from the plurality of drives storing the logical volume is selected, thus preventing a situation in which a request cannot be accepted.

Kakuta (US Patent No. 5,636,356) discloses a RAID apparatus for selecting a copied data drive when read requests are concentrated on a particular drive. In order to detect the concentration to the particular drive, the read request issued to the particular drive at a predetermined interval are stored, and when the count exceeds a preset count, I/O is switched to a duplex drive is switched (see column 14, lines 35-49). Therefore, to prevent a concentration of a load to a particular drive, the number of read requests are counted for a selected drive, and when the counted value exceed a predetermined value, the non-selected drive having same logical volume is selected. Therefore, Kakuta discloses a method of releasing a concentrated load of a RAID drive, but does not disclose a request balancing of RAID drives as in the present invention.

Since the Kakuta apparatus compares the counted value to a predetermined value, and selects another drive when the counted value exceeds the predetermined value Kakuta does not disclose comparing the counted value of requests for each drive having a same logical volume and selecting the drive having a minimum counted value, as in the present invention.

In addition, and also since the Kakuta apparatus compares the counted value to a predetermined value, and selects another drive when the counted value exceeds the predetermined value Kakuta does not disclose performing balancing control as in the present invention. The Examiner's assertions that the Kakuta apparatus performs balancing when accessing another disk the counted value of a disk unit exceeds a threshold are traversed. Kakuta discloses that one count value is compared to a threshold to determine whether to

access a drive, but does not disclose that count values are compared with each other to determine which drive to access as in the present invention. Thus, in contrast to the Kakuta apparatus, the present invention continuously performs balancing control since the drive having a minimum counted value is always selected in the present invention, thus allowing high speed accessing to be performed by the RAID apparatus.

Further, in Kakuta, selection of a drive can not be performed when the counted values of all drives having a same logical volume exceeds a predetermined value, as in the case of large requests. In contrast to Kakuta, in the present invention, though the request to the particular logical volume is large, any one drive is selected, thus preventing the occurrence of a situation in which a large request cannot be accepted.

In addition, the Examiner's assertions that Kakuta discloses the incrementing and the decrementing number of operations are respectfully traversed. Kakuta discloses the counting of the number of requests within a predetermined interval, but does not disclose the incrementing of the number of the selected drive and the decrementing of the number of operations completed by a drive as in the present invention.

Moreover, Kakuta does not disclose the validation table for the disk unit as in the present invention.

Miskowiec (U.S. Patent No. 5,915,095) discloses a network router for selecting a one of servers by comparing a processing capacity of each server. In Miskowiec, the processing capacity is described as a current network servicing which is defined as the number of network

nodes to be supported and a current common application request servicing which is defined as the number of network node requests to be supported by a common application. Further, Miskowiec discloses a server selecting method, but does not disclose a drive selecting method of a RAID array as in the present invention. Moreover, Miskowiec discloses a server selecting method using a request number, but does not disclose counting the request numbers and comparing the counted request numbers as in the present invention.

In addition, Miskowiec does not disclose the counting of the number of requests within a predetermined interval, but does not disclose the incrementing of the number of the selected drive and the decrementing of the number of operations completed by a drive as in the present invention.

The combination, then, of the disclosures of Kakuta and Miskowiec is an apparatus which counts the number of requests made to a particular disk drive, and, when the number of requests exceeds a predetermined threshold, makes requests to another disk drive instead of the particular disk drive, and, further, tracks the number of requests to a server of a network.

In summary, Kakuta compares the number of requests made to each disk drive to a predetermined number, then selects another logical disk drive when the predetermined number is exceeded. Miskowiec is directed to balancing processing requests among a number of servers, each of which have a copy of a particular application. In contrast to the foregoing references relied upon, the present invention is a RAID apparatus balancing requests made to

disk drives. Each of independent claims 1, 7, and 13 recites the foregoing features. Neither of the foregoing references relied upon discloses or suggests same.

More particularly, independent claims 1, 7, and 13 recite (using the recitation of claim 1 as an example) "compares numbers of operations corresponding to a plurality of physical disk units which store said designated logical volumes with each other, and selects the physical disk unit which has a minimum number of operations" and "wherein said control means increments the number of operations of said designated physical disk unit in accordance with a request for said operation and decrements the number of operations of a physical disk unit whose operation has been completed, in accordance with an end of said operation".

New claims 14-16 recite similar features of the present invention.

The benefit of the foregoing features of the present invention is that the drive having a minimum count value is always selected. Therefore, balancing of the requests is always performed. Accordingly, high speed access of the disk units can be performed.

Further, in the present invention, although there are a large number of requests made to a particular logical volume, a drive storing the logical volume is selected, preventing the situation in which the request cannot be accepted.

Dependent claims 3-6 and 9-12 recite patentably distinguishing features of their own. For example, claim 3 recites "a resource manager circuit determining one of the plurality of physical disk units to be accessed in accordance with said number of operations in said

memory in response to a transfer request from said channel adapter circuit, and requesting said device adapter circuit to perform an operation accessing said determined physical disk unit".

The benefit of the features recited in claim 3 is that the disk unit to be accessed is determined by the resource manager included in the "control means".

Withdrawal of the rejections of remaining, pending claims 1, 3-7, and 9-13 under 35 U.S.C. §103 as being unpatentable over Kakuta in view of Miskowiec is respectfully requested.

The foregoing objections and rejections having been overcome and new claims 14-16 having been added, the application is in condition for allowance, which action is earnestly solicited.

Respectfully submitted,

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